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PACIFIC NORTHWEST WATER LABORATORY QUARTERLY REPORT

Pacific Northwest Water Laboratory
Corvallis, Oregon

April 1969

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QUARTERLY PROGRESS REPORT

PACIFIC NORTHWEST WATER LABORATORY CORVALLIS, OREGON

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FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
NORTHWEST REGION

42

PACIFIC NORTHWEST WATER LABORATORY

QUARTERLY REPORT

January 1 through March 31, 1969

United States Department of the Interior
Federal Water Pollution Control Administration
Northwest Region, Corvallis, Oregon

April 1969

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OFFICE OF THE LABORATORY DIRECTOR

Dr. Bartsch lectured to and reviewed on-going and planned activities of the Limnology Department of the Academy of Natural Sciences of Philadelphia; the Water Resources Center of Ohio State University at Columbus; and the Department of Zoology of Indiana University at Bloomington.

Dr. Bartsch attended two meetings of the Project Advisory Committee to the Upper Great Lakes Commission on Inland Lake Renewal and Management Demonstration, held in Madison, Wisconsin.

Dr. Bartsch appeared as an expert witness at the Potomac River Enforcement Conference, held in Washington, D. C.

NATIONAL EUTROPHICATION RESEARCH PROGRAM

9841/1601 and 9884/000

GENERAL

By invitation of a representative of the Fisheries Research Board of Canada, Dr. Bartsch assisted in planning research activities for controlling eutrophication in small lakes in the Prairie Province area of Canada at a meeting held in Winnipeg on January 11.

At the request of the Office of Science and Technology of the Executive Office of the President, Dr. Bartsch represented the United States at an Expert Meeting on Eutrophication Research, held in Paris, France, on January 27-29, under the Advisory Group on Water Management Research of the Organization for Economic Cooperation and Development.

Dr. Bartsch attended a meeting of the Joint Industry-Government Task Force on Eutrophication, held in New Brunswick, New Jersey; he serves as Chairman of the Research Committee of this organization.

At the request of the Florida Air and Water Pollution Commission, Dr. Bartsch, along with representatives of the Southwest Regional Office, made an on-the-site inspection of Lake Apopka and gave consultative assistance in connection with eutrophication problems involved.

Dr. Powers participated in a Water Resources Planning Meeting February 9-10 at Lansing, Michigan, relative to phosphorus removal from sewage tributary to Lake Michigan. This participation was at the invitation of the Michigan Water Resources Commission. The meeting was called by the Joint Legislative Committee on Water Resources Planning of the Michigan Legislature.

Dr. Bartsch attended a meeting of the advisory group to the Eutrophication Institute at the University of Wisconsin where reviews were given of projects being supported by the FWPCA.

At the invitation of the Great Lakes Basin Commission, Dr. Powers moderated a session at a conference on the Application of Systems Analysis to the Great Lakes held at Ann Arbor, Michigan, March 18-21.

PHYSIOLOGICAL CONTROL BRANCH

Status of Projects and Significant Accomplishments

Physiology Section

Studies to determine the minimum and optimum nitrogen and phosphorus requirements for the growth of Selenastrum capricornutum were continued both in static and continuous flow assays. Tentative results show that, when other nutrients are not limiting, growth responses to phosphorus in concentrations ranging from 0.10 to 0.62 mg/l are similar. In the case of nitrogen, algal growth was similar in concentrations ranging from 0.14 to 14.0 mg/l.

A comparison was made between methods and techniques for assessing algal biomass in cultures of Selenastrum capricornutum and Anabaena flosaquae. Dry weight and absorbance determinations can only be employed validly when growth is fairly dense. Determination of cell numbers with the Coulter Counter is the most accurate method of S. capricornutum, especially at low cell densities. A. flos-aquae, being a filamentous alga, is not amenable to use of this method. The fixation of ^{14}C, however, was found to be a sensitive and reproducible procedure for determining growth of this alga.

Algal Assay Procedures Section

The printing of the Provisional Algal Assay Procedure (PAAP) was completed. Thus far, requests for approximately 300 copies have been filled.

The design and construction of three--four reactor unit--continuous-flow chemostat systems were completed. Studies have been made relative to the hydraulic inflow and discharge efficiency of the chemostats. The maximum residence time for the 1000 ml reactor is 13-14 days. Algal productivity in an aerated reactor is greater than that in an unaerated reactor.

Aquatic Plant Control Section

The pilot scale evaluation of phycoviruses for blue-green algae control is being conducted at Syracuse University under a contract research grant. Preparations, including the culturing of viruses and algae, are underway and the evaluation will begin as soon as weather permits.

ECOLOGICAL CONTROL BRANCH

Status of Projects and Significant Accomplishments

Nutrient Control Section

A field study to investigate the effect of hypolimnetic aeration and destratification on nutrient availability and algae production was initiated in January 1969 on Cline's Pond, about 20 miles north of Corvallis. A contract agreement with the owner will permit experimental manipulation of this one-acre eutrophic body of water. Plastic sheets are being used

to partition the pond into sections, one of which will be subjected to aeration and another held as a control. Background limnological data collection on the pond began in January.

Meetings have been held with Professor Jack Donaldson, Oregon State University, and with personnel of the U. S. Forest Service relative to the proposed study of incipient eutrophication in Waldo Lake. A contract is being negotiated with the U. S. Geological Survey for installation of gaging equipment on the outlet of the lake. It is planned to initiate physical-chemical-biological monitoring of the lake in early summer.

Studies on the nutrient content of rain and snow have continued. Snow samples were obtained from the Waldo Lake drainage, and rain and snow samples from the Corvallis and Klamath Falls areas.

A coordinating body for the Detroit Lakes study has been organized, known as the "Lake Sallie Weed Control Study Group." The first meeting was held in Fargo, North Dakota, in February. It was decided to postpone weed harvesting in Lake Sallie until 1970, to permit collection of adequate pre-harvest background limnological data. Experimental spray irrigation with secondary effluent by the Soil Conservation Service will be postponed until present experimental work is concluded. Chemical analysis of sediment samples and aquatic weeds from Lake Sallie has continued at the Corvallis Laboratory.

Laboratory studies of nutrient removal in soil columns, and of nutrient transport through a thermocline are continuing. A report on results of the soil column studies is in preparation.

Sediment-Water Nutrient Interchange Section

Emphasis during the past quarter has been on laboratory interchange experiments and analysis of sediments from lakes representing various geographical areas and lake types. These lakes were: Upper Klamath Lake, Oregon; Lake Herman, South Dakota; Lake Sallie, Minnesota; Woahink Lake, Oregon; and the Salton Sea, California. The sediments of oligotrophic Woahink Lake were sandy and contained only traces of soluble orthophosphate, whereas the remaining lakes investigated are eutrophic and exhibit high levels of phosphorus and other nutrients in the sediments. In a 32-inch core from Lake Herman, for example, the orthophosphorus in the interstitial water of the core varied from 0.8 mg P/l in the upper 12 inches to 2.4 mg P/l at the 22 to 32 inch level.

Further studies on the effects of freezing of sediments showed increases of both ortho- and total phosphorus in Lake Sallie interstitial water. Orthophosphate increased from 0.4 to 1.3 mg P/l, and total soluble phosphorus from 0.55 to 6.7 mg P/l. These results conform to those obtained in freezing studies on sediments from other lakes.

Laboratory interchange tests of nitrogen and phosphorus were continued, using sediment and water from Upper Klamath Lake. A two-fold increase in total phosphorus and nitrogen in the water phase (biomass included) under algal growth conditions was found, and an apparent shift of nitrogen and phosphorus from the water to the sediment took place as algal growth decreased.

Several trips were made to Upper Klamath Lake to monitor winter conditions and to obtain water and sediment samples for laboratory use.

A working paper by A. R. Gahler entitled "Field Studies on Sediment-Water Algal Nutrient Interchange Processes and Water Quality in Upper Klamath and Agency Lakes" is in manuscript.

Shagawa Lake Project

Field work during the past quarter was severely limited by weather conditions. Insufficient ice cover precluded work on Shagawa Lake. Sediment samples were obtained for the Corvallis lab during much of the winter and recently water samples were taken for use in PAAP tests at Corvallis. A cooperative project with the Cincinnati Water Research Laboratory on sludge freezing experiments is being conducted.

Emphasis was placed on completing chemical analysis of water samples obtained during the 1968 field season. A number of these samples were sent to Corvallis for analysis.

Data work-up and initial reporting on pilot plant operation and efficiency, the nutrient and water budget of Shagawa Lake, and the 1968 field experiment program were begun during this quarter. These reports will receive high priority during the fourth quarter, FY 1969.

Grant and Contract Research

Technical reviews of preproposals and proposals for research grants, demonstration grants, and contracts were provided for the following subject matters:

1. "Biochemistry and Physiology of Nitrification"
2. "Biochemistry and Ecology of Autotrophic Microorganisms"
3. "Eutrophication in Coastal Waters"

4. "Nutrient Enrichment: Role of Organic N in Growth of Phytoplankton Populations"

5. "The Role of Silica in Water Quality Control"

6. "Preliminary Phytoplankton Survey of Great South Bay"

7. "Biological Models of Freshwater Communities"

8. "An Investigation of Algal Lytic Agents"

9. "Eutrophication-Biostimulation Assessment Workshop"

10. "Limiting Nutrients and Temperatures for Southern California Coastal Phytoplankton"

11. "Algal Diseases and Possible Application"

12. "Research and Development of a Selective Algaecide to Control Eutrophication"

13. "Demonstration Studies of Flushing Small Shallow Lakes"

14. "Water Quality Control with Polymeric Flocculants"

15. "Effects of NTA on Lake Sediments"

16. "Bottom Sediments and Water Quality"

17. "Ion Exchange Properties of Phosphate Solutions"

18. "Nutrient Cycles and Eutrophication in Great South Bay"

19. "Limnology of John Redmond Reservoir, Kansas"

20. "The Role of Tubificidae (Sludge Worms) in Maintaining the Eutrophic Status of Lakes"

21. "Dynamics of the Eutrophication of a Main-stem Reservoir by Phosphorus"

22. "Community Analysis in the Littoral Zone of Lakes"

23. "The Carbon Dioxide System and Eutrophication"

24. "Nitrate Nitrogen and Phosphorus in Lake Eutrophication"

25. "Role of Nitrogen (NO_2^-, NO_3^-, NH_4^+) in Lake Eutrophication"

26. "Eutrophication and Fish Growth in Lake Washington"

27. "A Study to Evaluate the Effect of Silt and Silt Removal in a Northern Prairie Lake"

28. "Investigation of Phosphorus Availability in Oligotrophic Lakes"

29. "A Real-time Chemical Study of a Riverine Reservoir"

30. "Sediment-Water-Bacteria Interaction in Eutrophication"

31. "Phosphorus in Aquatic Ecosystems, Model Experiment"

Plans for Fourth Quarter, FY 1969

In Nutrient Control, work will intensify at Cline's Pond as the experimental research gets under way. Laboratory work on nutrient transport through a thermocline will continue, and work will be initiated on nitrogen fixation and nutrient requirements of rooted aquatic plants. Investigation of nutrient content of rain and snow and preparations for the Waldo Lake studies will continue.

In Sediment-Water Interchange, research related to *in situ* experiments on inhibition of sediment-water nutrient interchange will go forward. Plans are being formulated for fabrication of large plastic experimental enclosures which will be placed in Upper Klamath Lake. A cooperative project with the FWPCA Cleveland laboratory in a study of dissolved oxygen depletion in Lake Erie will begin June 1969. Sediment from Lake Erie will be sent to this laboratory for analysis and experimental treatment. Laboratory research on nutrient interchange will continue, and attention will be given to development of experimental lake dredging programs.

Preparations for the coming field season are under way at Shagawa Lake. This year, in addition to the large 150,000 gallon basins, stimulation of algal growth will be studied in smaller in-lake vessels of approximately 150 gallons and 5 gallon capacities. The PAAP will be employed to evaluate the biostimulatory responses of algae to samples in connection with the Shagawa Lake, Minnesota, project. The samples will include primary sewage effluent, secondary sewage effluent, Shagawa Lake water and Burntside Creek water. Burntside Creek is the primary contributor of water to Shagawa Lake.

Studies will be continued to determine the environmental and nutritional requirements of the PAAP test species. Studies will be initiated to evaluate the PAAP. Water samples from lakes at various trophic levels will be tested.

WASTE TREATMENT RESEARCH & TECHNOLOGY PROGRAM

9841/1204, 1206, 1210, 1301

PAPER AND ALLIED PRODUCTS RESEARCH BRANCH - 9841/1204

Status of Activities & Significant Accomplishments

Polymers in Waste Treatment

For the remainder of the project scheduled to terminate at the end of the current fiscal year, samples will be collected from four different pulp mills including bleached and unbleached sulfite pulp, kraft pulp, and a ground wood mill. Polymers showing best results to date will be tested on these samples.

Research Needs in the Pulp and Paper Industry

A listing of research needs and program plans for the State of Washington was prepared during the quarter. This was developed from the American Paper Institute research needs list for projects which could be implemented under the Section 6 grants program.

Grant and Contract Research Status

Research and demonstration grant projects listed on the preceding quarterly report are all still active. The Lebanon Crown-Zellerbach Project was delayed due to failure of major pumping equipment and resumption of the project is awaiting shipment of a new pump.

Plans for Fourth Quarter, FY 1969

Because of limitations on staff and financial resources, together with the considerable interest in FWPCA grant projects, most staff time during the quarter will be committed to review and monitoring of proposed

and existing grant projects. Plans are being completed for the initiation of in-house research studies including cooperative work in connection with the Crown-Zellerbach Lebanon grant project.

FOOD WASTES RESEARCH BRANCH - 9841/1206

Status of Activities and Significant Accomplishments

The draft of the final report on Burley, Idaho's, pilot plant operation was reviewed internally according to Administrative Circular, Communications No. 4. Following minor changes it was forwarded to the Regional Office for further action. Another meeting of the Engineering Committee of the Potato Processors of Idaho was attended to keep abreast of their current efforts. A meeting of NCA (National Canners Association) and various seafood processors was attended at Seattle, Washington, to partake in discussions related to waste treatment and disposal problems within their industry. A pilot plant used for drying of various wastes was viewed in operation on shrimp waste at Charleston, Oregon.

Grant and Contract Research Status

University of Washington (WP 01486-01-68): A draft of a portion of the State-of-the-art paper on potato processing was received and is being reviewed.

R. T. French Co. (WPRD 15-01-67): Construction continues as weather permits.

Snokist Growers (WPRD 58-01-68): Data analysis is continuing for final report.

Dallas, Oregon (WPRD 29-01-68): Construction still discontinued for winter months.

Four grant applications and one preproposal were reviewed.

Areas of Concern

There are now 25 grants outstanding in assigned areas with approval of five additional ones pending. These additional responsibilities continue to be expanded although no positions are assigned to the 1206 category.

Plans for Fourth Quarter, FY 1969

A number of visits will be made during the quarter to existing grant projects never previously inspected and a national meeting of the National Canners Association will be attended in Washington, D. C. A review meeting will be held during the quarter with selected individuals to discuss final preparation of the state-of-the-art report on potato processing waste treatment. Grant application and preproposal reviews continue to occupy a major portion of staff time. Some relief is expected and the initiation of some in-house research projects anticipated with the return of R. J. Burm to Corvallis at the conclusion of the Hawaiian Sugar Waste Study during the fourth quarter.

SPECIAL STUDIES BRANCH - 9841/1210, 1301

Status of Projects and Significant Accomplishments

Lumber and Wood Products - 1210

Pilot plant activities on anaerobic treatment of urea glue and steam vat condensate is continuing. Data have been evaluated in the aerobic biological treatment study of urea glue and steam vat condensate.

Forestry and Logging - 1301

A statement of research needs and proposed work plans were completed.

Technical Projects Activities

The search continues for suitable sites for the Log Storage and Handling Project and some water and benthic samples were collected at selected sites to determine the effects of log storage on water quality.

Field activities in connection with the Study of Waste Treatment at Recreational Areas were concluded except for bench and pilot scale studies on specific treatment methods. A verbal progress report was given to the Ski Operators School in March in Missoula, Montana.

Grant & Contract Research

Project objectives on demonstration grant WPRD 174-01-R1-68, Klamath Plywood Corporation, have been reviewed and the request received for changes in these objectives. This has been done in light of review by the grantee of present waste disposal practices and the finding that in-plant changes can greatly reduce waste flows. No waste treatment plant construction has been undertaken.

Areas of Concern

No funds or positions have been assigned to research activities concerned with Forest Industries. Present activities are limited to those conducted with borrowed personnel.

Reports and Papers

The final report of the Plywood Glue Waste Study was completed and submitted for publication.

Plans for Fourth Quarter, FY 1969

Preparation of a draft of the final report on the Recreational Sites Study will begin during this quarter. An internal program review will be held on the Log Storage and Handling Project to determine new project objectives in view of expanded extra-mural research activities. Responsibility for national research activities in the Wood Products and Forestry and Logging categories will be transferred to the Paper and Allied Products Branch during the quarter with the transfer of Mr. B. D. Clark out of the program. Internal planning sessions will be held to determine FY 70 work plans to take into account revised staff and resources.

Status of Projects and Significant Accomplishments

Consultation and Advisory Services

All 5000 copies of the "Industrial Waste Guide on Thermal Pollution," released by the Secretary on January 10, were depleted by February 25. Reprinting of 5000 additional copies is in progress; copies will be available early in the fourth quarter, FY 1969.

The staff, assisted by the Duluth Laboratory, held Technical Seminars on Thermal Pollution Control in Ada, Oklahoma, January 6-7; Athens, Georgia, January 9-10; Cincinnati, Ohio, February 3-4; Metuchen, New Jersey, February 6-8; and Charlottesville, Virginia, February 10-11.

Assistance was provided the Great Lakes Regional Office relative to a proposed power plant site on Lake Erie; to the South Central Regional Office relative to a proposed power plant on Dardanelle Reservoir; and to the Southwest Regional Office concerning expansion of the Four Corners Project by Southern California Edison Company.

At the request of the Missouri Basin Region, Alden Christianson presented a paper, "Thermal Pollution," to the Missouri Water Pollution Control Association Annual Meeting, February 25.

In February Mr. Rainwater participated in an intradepartmental meeting at Headquarters on delineation of thermal mixing zones and implementation of water quality standards. NTPRP will provide technical support on this work.

Completion dates on the state-of-the-art document, "Status of Thermal Pollution and Research Needs," have been extended to April 15, 1969, for the portion on Engineering and Economic Considerations and until August 1, 1969, for the portion on Biological Effects.

Proceedings of the two Symposia on Thermal Pollution are in galley proof; publication is anticipated in the fourth quarter, FY 1969.

Sources of Heat Input to Water

A project was started to refine the presently used techniques for predicting evaporative heat loss by putting them on a sounder theoretical basis and lessening their empiricism. A field study will be conducted on a small stream in the arid region of Oregon. Evaporation rates will be determined by an energy budget on the stream and, in addition, evaporation pan data will be collected. Wind velocities will be taken in two elevations within the turbulent boundary region. Equations based on the mass transfer within the turbulent boundary region will use this wind profile data and humidity measurements to compute evaporation rates. These rates will be compared to those determined from the energy budget to determine the applicability of these equations to small turbulent streams.

Effects of Heat Management on the Environment

Plans were finalized and equipment ordered to study the effects of steam condenser water on the mortality and reproduction of zooplankton. This research is to provide answers to the following questions:

1. What are the lethal temperatures for some important species of zooplankton?

2. Are temperature effects cumulative?

3. What are the effects of thermal shock upon reproductive ability?

4. What would be the effect of condenser or thermal plume temperatures upon zooplankton?

Plans were finalized and equipment ordered to study effects of a floating hot water lens on the emergence of aquatic insects. The primary purpose of the experiment is to determine whether hot effluents to water will be harmful to the insect population when the hot water is floated on top of cool water and the insects contact this hot layer only during emergence.

Effects of Temperature on Fresh and Marine Fish Species

See Biological Effects Research Program Report, Page 28.

Engineering and Cost Aspects of Heat Dissipation

A mathematical model has been developed for evaluating design data for counterflow and crossflow natural draft cooling towers. Description of this model will be distributed in the fourth quarter.

The loss of water due to evaporation in cooling is a major economic concern to semi-arid regions and may also be associated with possible adverse meteorological effects. Plans were finalized and equipment assembled to study the efficiency of covered cooling ponds in decreasing the amount of water lost through evaporation in the cooling Process. The effects of induced turbulence to reduce evaporation loss in wet cooling towers is also being researched. In the lab, turbulence will be induced in the film motion generated on an endless belt.

LocalMeteorological Effects of Cooling Towers

A synoptic report by Dr. Fred Decker, Associate Professor of Physics, Oregon State University on "Cooling Towers and Weather" is in final

manuscript form. Distribution is anticipated in the fourth quarter.

Design Criteria for Heat Discharge Outfalls

Theoretical work is underway on turbulent diffusion of a heated plume. Under reasonably restrictive conditions a mathematical model is available to predict the statistical behavior of small particles in a turbulent field. This model may be extended to cover the behavior of other (tagged) fluid beds such as in a heat wake. Experiments will be conducted to obtain compiled Langrangian and Eulerian statistical data of the same flow fields.

General

Mr. Rainwater participated in a meeting January 22 with Edison Electric Institute, various power companies and other Federal agencies. The purpose of the meeting, organized by Johns Hopkins University, was to improve cooperation and coordination of private and government sponsored research.

Grants and Contracts

Reviews of applications for research grants were made on the following subjects:

1. "Processes of Heat Removal from Bays & Estuaries" and "The Sea-Breeze Circulation and Water Surface Exchange"

Reviews of proposals or scope of work on contracts were made on the following subjects:

1. "Effects of Heated Discharges in Great Lakes"
2. "Research on Fossil-Fueled Superheaters for Nuclear Power Plants"

3. "Studies on the Utilization of Waste Heat from Nuclear Power Plants in Artificially Mixing the Great Lakes"

4. "Use of Underground Water Strata for Dispersion of Waste Heat"

5. "Methods of Rejecting Waste Heat to the Atmosphere"

6. "Non-Evaporative Cooling Towers"

7. "Suggestions for Development of Structure in Inland Cooling Waters"

Areas of Concern

The need for better technology to predict thermal behavior in the "mixing zone" of a water body remains the top priority research need.

Discussion with Regional Directors and power industry representatives are pointing up the importance of the coastal areas in the United States, and the need for priority research therein. It appears that the coast is going to be the preferred location for many new power plants. Research on both the engineering aspects of heat transport and behavior and the biologic effects should be given high priority.

Reports and Papers

Alden Christianson presented a paper titled, "Thermal Pollution," February 25, 1969, at the annual meeting of the Missouri Water Pollution Control Association.

Plans for the Fourth Quarter, FY 1969

With the technical seminar series completed, most needed equipment ordered and the weather breaking, the major thrust in the fourth quarter is to activate fully the intramural research described in the section on status of projects.

NATIONAL COASTAL POLLUTION RESEARCH PROGRAM - 9841/1607

Status of Projects and Significant Accomplishments

CHEMICAL/BIOLOGICAL OCEANOGRAPHY BRANCH

1. Kraft Mill Effluent Plumes: Sufficient work has been accomplished to indicate that kraft mill effluents can be followed from the outfall down the plume through a substantial dilution factor, should it become necessary to do so. The measurement is made at the laboratory on samples taken in the field. We have installed a field sampler in our boat which could automate sample taking and handling in the field.

In previous work on gaseous tracers for reaeration studies in shallow streams, hand operations, i.e., wading into streams to dose and to obtain samples was practical. In work of this nature in estuaries, it was obvious that a mechanical system operable at various depths with a considerable degree of automation was required. We have constructed, installed, and operated such a device on dye tracer work on the Yaquina. A further development underway will allow radioactivity measurements in situ, whereas, at present, samples of radioactivity must be brought back for laboratory measurements. The dosing material portioned and packaged for dispersing by vendors is extremely expensive per run. Since it is anticipated that numerous runs will be made at various estuaries, we are developing an apparatus for handling, dispensing, and packing individual does. This will be located at the OSU Radiation Center.

A benthic respirometer has been completed and put to an initial mechanical test in Yaquina Bay at the dock of the OSU Marine Science Center at Newport, Oregon. This device is intended for use in studies of the oxygen kinetics resulting from bottom sediment disturbances as in dredging operations.

2. Biological Assessment: Plans were made for a training course, "Quantitative Evaluation of Biological Information Obtained in Coastal Waters," to be held at the Pacific Northwest Water Laboratory April 22-23. Drs. Saul Saila, University of Rhode Island; Henry Regier, University of Toronto; Howard Sanders, WoodsHole Oceanographic Institute; and John McGowan, Scripps Institution of Oceanography, will serve as lecturers for the course. An invitation was sent to each of the coastal Regional Offices and Headquarters to nominate attendees at the training session.

Additional work on the preparation of guidelines for conducting predischarge site evaluations and post-discharge monitoring will be conducted by the National Marine Water Quality Laboratory, in cooperation with our program.

3. NAS-NAE Report: Working groups preparing the National Academy of Sciences - National Academy of Engineering Report on management of wastes in the coastal environment are scheduled to meet for a few days commencing July 7. Each working group is to have ready preliminary papers as a definitive step toward the final report. The FWPCA members of the various working groups are expected to contribute material on FWPCA activities in coastal waters. We have, therefore, requested

information from the Water Pollution Surveillance Branch and the Office of Estuarine Studies at Washington headquarters and input from each coastal Regional Director concerning projects now underway, problems for which no work has as yet been commenced, and recommended siting for additional coastal pollution facilities per particular regional requirements, for our compilation, analysis, and inclusion in the material to be considered at the meeting.

PHYSICAL OCEANOGRAPHY BRANCH

1. Coastal Distribution of Pollutants: A method has been developed to determine the dilution and height of rise of waste fields discharged from ocean outfalls (applies to lakes also) with any angle of discharge and under any situation of density stratification. For the present it has been necessary to restrict the solution to cases where the current in the receiving fluid is not important. A report has been drafted describing the analytical approach and is under review prior to distribution. The computer program has been tested a limited number of times but sufficiently to provide some estimate of costs and the ability to cope with various cases. For instance, on the CDC 3300 it requires 25 seconds to analyze a typical discharge under 10 possible density regimes. At present this represents a cost of $2.00. Approximately three minutes of typist or keypunch time is required to set up the problem data.

In the interest of testing the solution, we would like to analyze any cases suggested by readers of this report. If a check on operating systems is requested, we will need to know:

A. Waste flow, M^3/sec, and density kg/m^3

B. Number, spacing, size, and orientation of ports, in meters, and degrees from horizontal.

C. Depth of water over ports, m

D. Representative density profiles, either as an analytical function, a tabular listing, or a graphical representation.

We would also like to know how close the computed values agree with actual observations--either before or after we provide the former. If this period of testing proves satisfactory, a small sub-program will be added to output a selection of diffuser designs and depths to meet user inputs of dilution and submergence requirements.

2. Columbia River Estuary Temperature Model: The first verification run on the hydraulics of the Columbia River was made. Input data consisted of river flows, initial water elevations for 260 junctions, and current speeds for 276 channels. Depending on the closeness of the initial conditions of the model to the prototype, the numerical solution will converge, stability permitting, after a few hours simulation of the prototype. The solution was stable for a Mannings' $\underline{n}$ = 0.02 in all channels and an integration period of 2 minutes; it was unstable for n = 0.025. No attempt has been made yet to assign individual $\underline{n}$'s to each channel.

3. Estuarine Diffusion of Pollutants Project: Technical reviews on a point score basis were made on 19 bid submissions for the state-of-the-art report. Preliminary plans were made for outlining suggested participation by Regional Office representatives to the technical sessions.

PROBLEM ANALYSIS AND ENGINEERING DEVELOPMENT BRANCH

B. David Clark, a senior sanitary engineer, will transfer to the staff from Waste Treatment Research and Technology filling the vacancy created by the transfer of William Clothier, our senior biologist, to the Regional Office. Preparation of a research and development program for pollution control from barge dumping will begin soon. Upon completion of Lake Superior study report, preparation of the state-of-the-art report on ocean outfall design will be resumed.

Grant and Contract Research

Technical reviews were provided on applications and proposals for research grants and contracts related to the following subjects:

1. "System Analysis of Thermal Loading in an Estuarine System"
2. "Wind-induced Currents in Stratified Lakes"
3. "Investigation of Factors Controlling the Distribution and Fate of Lead in Controlled and Natural Rivers and Estuaries"
4. "Effects of Heat Discharges in Great Lakes"
5. "Sub-bottom Profiling Study of Chesapeake Bay"
6. "Effect of Wind on Advection and Dispersion in A Shallow Estuary"
7. "Limiting Nutrients and Temperatures for Southern California Coastal Phytoplankton"
8. "Field Study of Aeration Processes in a Shallow Estuary"
9. "Pipeline Disposal of Sediment in Estuaries"
10. "Aerobic Digestion of Sewage Sludge with Effluent Disposal by an Ocean Outfall"

11. "An Investigation of the Fate of Oil and Other Pollutants in the Beaches of the Coastal Zone Near Santa Barbara"

12. "Investigation of Surface Films - Chesapeake Bay Entrance"

13. "Description, Analysis, and Mathematical Modeling of Dissolved Oxygen and Oxygen Demand Distributions in Salt-marsh-bordered Estuaries"

14. "Flow and Dispersion of Warm Water Discharged into Lakes and Rivers"

Areas of Concern

Additional staff is required to handle technical assistance and consultations for projects peripheral to our current program.

Equipment

Thirty used film recording Richardson (Geodyne) current meters were received on loan from the Great Lakes project.

Plans for Fourth Quarter, FY 1969

Chemical/Biological Oceanography Branch - A gas-handling system for preparing radioactive tracer doses will be initiated at the Radiation Center, Oregon State University, to prepare samples for our radiation studies.

Reaeration runs on the Yaquina estuary will be continued, using automated sampling equipment now installed aboard our vessel.

Our benthic respirometer equipment will be taken to Puget Sound for respirometric measurements before proposed dredging operations are commenced.

Physical Oceanography Branch - Further verification runs at different river flows and roughness coefficients will be made. The entire temperature model will be tested with an initial temperature time step of one hour. Work on the user's manual will continue.

The contract for the state-of-the-art report will be awarded. The project officer for this contract will work closely with the contractor in setting up meeting place, scheduling the technical sessions, informing FWPCA representatives of progress, and selecting the participants to be invited to write various chapters of the report.

Problem Analysis and Engineering Development Branch - A research and development program for pollution control from barge dumping will be initiated. Work will be resumed on preparation of the state-of-the-art report on ocean outfall design.

Status of Projects and Significant Accomplishments

Thermal Pollution Studies

1. Simulation of Adult Salmon Migration Through Elevated Temperatures: The testing facility at Bonneville was reassembled and checked for winter damage, which proved to be negligible. One unit was activated to determine its heating capacity. The unit responded favorably and confirmed that the present heating capacity is very adequate for maintaining the proposed temperatures. Additionally, a bench scale (1/10) prototype of the above recirculating system was assembled and tested at the Corvallis laboratory. Steelhead smolts (5/pound) were maintained with feeding for one month using less than 1.0 percent makeup water per minute. Ammonia levels were monitored and these never reached dangerous levels. These results indicate that the Bonneville facility will be capable of maintaining good water quality for non-feeding adults.

2. Tissue Enzyme Studies: The optimum extract concentration of tissue (usually brain, muscle, and liver) was determined for the *in vitro* assay of the following enzymes in juvenile coho salmon: (1) α-hydroxybutyric dehydrogenase (α-HBD); (2) lactic dehydrogenase (LDH); (3) phosphohexose isomerase (PHI); (4) glutamic oxalacetic transaminase (GOT); (5) glutamic pyruvic transaminase (GPT; (6) leucine amino naphthylamidase (LAN); (7) isocitric dehydrogenase (ICD); (8) alkaline phosphatase; (9) acid phosphatase; and (1) cholinesterase. These enzymes probably represent less than 0.1 percent of the total number of enzymes in fish. The *in vitro* heat lability or inactivity

of each of these enzymes was determined by conducting the enzyme assays at temperatures ranging from 15 to 35°C. Enzyme activity usually increases lineally with temperature and approximates Van't Hoff's law until the enzyme is adversely affected, whereupon enzyme activity decreases. The temperature at which the latter occurred was defined as the labile temperature in these assays. Cholinesterase and GPT were found to be irreversibly denatured by high temperatures; studies of the other enzymes are still to be conducted.

Additional testing of soluble cholinesterase on a pilot scale with live fish was conducted because it is labile in vitro at sub-lethal temperatures and because this temperature effect is irreversible. Live coho smolts acclimated to 8°C were warmed progressively to 26°C over a three-hour period. Groups of three fish each were removed at 8, 20, and 26°C and assayed for soluble cholinesterase activity per unit wet weight of brain. The levels of enzyme activity were not affected at or below 20°C, but soluble brain cholinesterase was inhibited in the live smolts that had been warmed to 26°C. The above results are important because they demonstrate a case of close agreement between in vitro and in vivo enzyme lability. The relationship between the enzyme activity in the soluble fraction and the activity in whole homogenates is currently being investigated, and until this portion of the study is completed, these results can only be regarded as preliminary.

Adverse Properties of Sulfite Waste Liquor (SWL)

Coho salmon tests were completed for the 1968 spawning season and the results are being compiled in a preliminary report. Significant

results include the following:

1. SWL decreased the effective life of sperm from 30 seconds to less than 10 seconds at 500 ppm of SWL.

2. A preliminary experiment to determine the effect on the fertilization of eggs when washed extensively to free them of ovarian fluid, indicated that such treatment increases the gametocidal effect of 540 ppm of SWL.

3. Sex products are more sensitive to SWL in isotonic saline than in creek water.

4. SWL begins to decrease fertilization success of unwashed eggs (with copious amounts of ovarian fluid) in isotonic saline at SWL concentrations ≥ ca. 200 ppm. However, this effect was small and fertilization averaged 73 percent at 500 ppm SWL. Very little effect was noted when the same tests were conducted in creek water.

5. Survival to feeding stage (swim-up) was determined for eggs that were fertilized and then placed in artificial redds (nests). In the control section, approximately 6 percent of the eggs were infertile, but the remaining 94 percent hatched after the expected incubation period. After hatching, these fry remained in the gravel and emerged when they reached the feeding stage. In contrast to this, the presence of 50 ppm SWL was associated with embryo and fry mortality (21 percent), early hatching (ca. two weeks), premature emergence (as sac fry), and a total survival of 74 percent.

Subsequent to the coho study, steelhead eggs were tested in February. All eggs were washed slightly to remove excessive ovarian

fluid which is characteristic of artificial spawning. This washing is necessary to approximate natural conditions. The preliminary results are listed below:

1. SWL was considerably more deleterious to the fertilization of washed eggs, both in saline and creek water, than was the case for unwashed eggs. Hence, the sensitivity of the fertilization test has been improved greatly.

2. Fertilization of washed steelhead eggs was adversely affected beginning at concentrations of less than 100 ppm SWL. Less than 10 percent fertilization occurred at concentrations of 575 ppm SWL in creek water.

Fertilized steelhead eggs were also placed in artificial redds to determine the effects of 50 ppm SWL.

Further testing was not possible due to limitations of specimens and manpower.

Areas of Concern

As before, the water supply and facilities remain highly restrictive and inadequate. Fluctuation in the quality of water that supplies the fish tanks is a major concern and has in the past negated experimental results.

Reports and Papers

A paper entitled "Thermal Pollution from a Fish Physiologist's Point of View" was presented informally by the Program Chief at the annual meeting of the Pacific Fishery Biologists held at Harrison Hot Springs, British Columbia, in March.

Equipment and Facilities

Final blueprints and specifications have been completed for the proposed Bioeffects Laboratory. As yet, no construction money has been allocated.

Plans for Fourth Quarter, FY 1969

The Bonneville facility will be reactivated and given a full-scale test using adult spring chinook. Tests of thermal effects will begin in June using adult sockeye salmon.

We will continue to determine thermal effects to enzymes *in vitro* and compare the results between species. *In vivo* studies will be started.

The present SWL studies will be terminated on schedule and the resulting data will be reported.

TRAINING AND MANPOWER DEVELOPMENT - 9825/000

Status of Projects and Significant Accomplishments

Direct Training

"Design and Management of Sewage Treatment for Small Federal Installations" training course was held January 6-10 and January 20-24 at the laboratory for a total of 48 trainees.

The "Nutrient Removal and Advanced Waste Treatment" seminar was held in Portland on February 5-6 with approximately 200 people in attendance.

"Design and Management of Sewage Treatment for Small Federal Installations" training course was presented in Anchorage, Alaska, at the Alaska Methodist University during the week of February 10 for 68 students.

"Chemical Analyses for Water Quality" training course was held at the laboratory on March 10-21 for 24 students.

Cooperative Area Manpower Planning System (CAMPS)

An institutional-type training program for sewage treatment plant operators began April 7 at Linn-Benton Community College. The 26 students are from Idaho and Oregon.

Contacts have been made with Department of Labor representatives and state officials in the Northwest Region to discuss on-job training of sewage treatment plant operators. Washington and Oregon have applied for Federal funds for on-job training.

Tours and orientation were provided for approximately 500 people plus the loan of a film on water pollution control for viewing by approximately 75 people.

Use of lecture room facilities, audio-visual equipment, and visuals were provided laboratory staff members.

Grant and Contract Research

A review of training grant application from Oregon Technical Institute has been completed and comments forwarded.

Plans for Fourth Quarter, FY 69

"Laboratory Analyses in Treatment Plant Operations" May 5-16

Qualitative Evaluation of Biological Information Obtained in Coastal Waters - Seminar April 22-23, 1969.

CONSOLIDATED LABORATORY SERVICES PROGRAM

Status of Projects and Significant Accomplishments

1. Kjeldahl Nitrogen Analysis: The Kjeldahl nitrogen automated digestion system has been assembled and optimum digestion time and temperature conditions are being determined. The manual and automated systems are being run at all levels. Some difficulty is being experienced with reproducibility as a function of a refractory type of nitrogen samples.

A chart reader from surplus equipment has been developed to speed up the measurement of peak heights from the Technicon data presentation. The peak heights and base lines of samples and standards are determined and a computer program is used to calculate the answers. The analyst types into the computer all the necessary data. A computer program calculates the slope of the line and deviations from Beers Law based on standards. The analyst has full control of the data from the measurement of the peak height to the final answer.

2. Gas Chromatographic Analysis: The Fisher Hamilton gas partitioner has been set up to analyze for dissolved gases in water, particularly oxygen, carbon dioxide, and nitrogen.

3. Fluorometric Analysis: The Turner Model 210 Spectrofluorometer has been used to determine fluorescence of Kraft liquor. When wastewater Kraft liquor is excited at 210 mμ, it emits energy at 305 mμ. Pond effluent at Kraft mills was diluted 1000 to 1 with sea water; at this dilution it could be detected by fluorometric techniques.

A literature reported fluorescent cyanide determination appears to lack sensitivity when methanol and acetonitrile are used as solvents. A sulfate fluorescent determination was run on the Turner instrument. The fluorescent determination extended the level of sulfate to 5 mg/l, however, time considerations preclude the use of this technique.

4. Atomic Absorption Spectrophotometry: Sulfate and nitrate interfere with the determination of calcium by atomic absorption spectrophotometry. High nitrate levels depress the sensitivity of the analysis. Preparation of standards with the same level of nitrates as the samples solves the problem of sensitivity. The sulfate problem is more difficult to solve, but dilution of sulfate appears to be the approach to reduce the interference.

5. General Chemical Analysis: The anthrone method for low level sugar concentrations in wastewater is being evaluated.

By increasing the rate of oxygen flow through the carbonaceous analyzer, the time between injections has been reduced permitting an injection every 30 seconds.

6. Biochemical - Microbiological: Experimental work was started for the development of a reproducible seed for the BOD determination of spent sulfite wastewater.

7. Biology: A sample separating dish for separation and enumeration of benthic organisms was fabricated following directions that appeared in Progressive Fish Culturist, Volume 31, No. 1, January 1969, p. 32. The dish will permit more rapid separation and rapid enumeration.

Areas of Concern

Interfacing of the Technicon data presentation through the computer at Oregon State University with the necessary internal controls.

Reports and Papers

Analytical Techniques for the National Eutrophication Research Program.

Plans for Fourth Quarter, FY 69

A computer program for the intra-analytical quality control program will be made. Continuation of development of the automated Kjeldahl nitrogen analysis will take place. A study will be made to determine the k-rate for streams in the pollution surveillance network.

TECHNICAL ASSISTANCE AND INVESTIGATIONS - 9818A/000

Status of Projects and Significant Accomplishments

Flathead Lake Study

The final report is being cleared for publication.

Middle Snake River Study

Additional survey work is planned for late summer of 1969.

Kraft Mill Ocean Outfall Survey

Data from field surveys is being compiled and analyzed. Project is under supervision of TA&I, Northwest Region.

Treatment Plant Operational Data Survey

Regional program now being initiated under the Construction Grants Program.

Camp Angell Study

The final report is being reviewed at the Northwest Regional Office.

Benthic Oxygen Demand Study

Planning was completed and equipment was designed and fabricated. Equipment for field studies now being tested.

Ketchikan Bacteriological Study

Planning was completed and field studies will start May 5, 1969.

Plans for Fourth Quarter, FY 69

A bacteriological survey of the Ketchikan area will be made. The benthic oxygen demand study field work on the lower Willamette will be started.

POLLUTION SURVEILLANCE - 9822/000

Status of Projects and Significant Accomplishments

Sampling at all Regional surveillance stations was conducted monthly throughout the winter, results being reported simultaneously through SHAVES and STORET.

Special intensive sampling was conducted around the clock at three locations involving suspected water quality deficiencies. Sampling was also designed to yield indication of validity of previous sampling at the stations involved.

Reports have been prepared on the intensive sampling programs and copies have been distributed to appropriate offices.

A program has been written for use with the STORET system to identify violations of water quality standards within any given reach of stream. This program was prepared following a similar addition to the SHAVES system.

Personnel of the Pollution Surveillance Branch at Corvallis are being separated from that activity in order to combine all Technical Operations Activities at the Regional Office in Portland. For the spring and summer seasons one technician will be assigned to Corvallis in order to coordinate incoming samples, data sheets, and supplies which will continue to be served by the laboratory until duplicate facilities can be provided in Portland.

Plans for Fourth Quarter, FY 69

Routine sampling will continue. Long term BOD will be determined at about 20 special stations for the River Basins Planning Activity.